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(71) Applicant: GENERAL MOTORS CORPORATION [US/US]; P.O. Box 33114, Detroit, MI 48232 (US).

(72) Inventor: FLAUGHER, David, Charles; 106 West Meadowbrook Drive, Midland, MI 48640 (US).

(74) Agent: SCHWARTZ, Saul; General Motors Corporation, Legal Staff, P.O. Box 33114, Detroit, MI 48232 (US).

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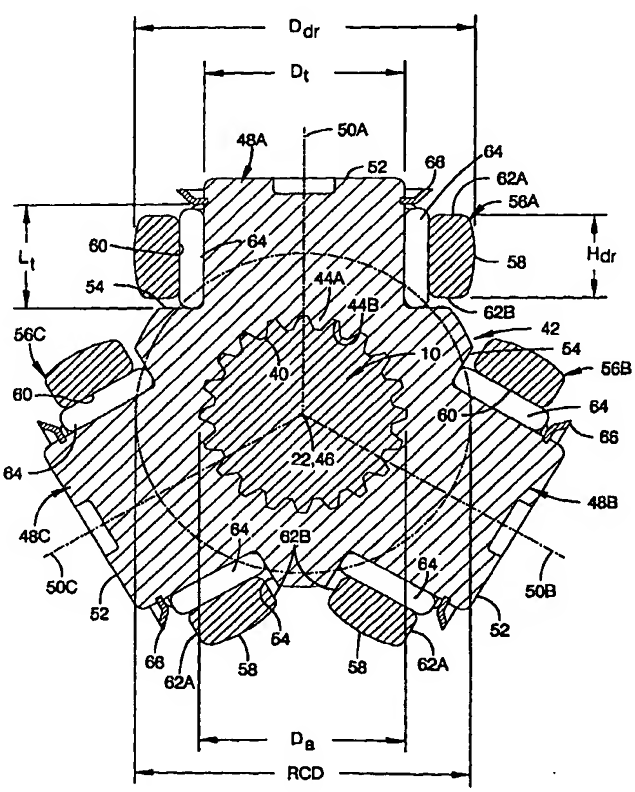
(54) Title: CONSTANT VELOCITY UNIVERSAL JOINT

(57) Abstract

A tripod constant velocity universal joint (12) including an outer housing (14) having three linear tracks (28A, 28B, 28C), a spider (42) having three cylindrical trunnions (48A, 48B, 48C) in the linear tracks and a splined bore (40) for an end (38) of an axle bar (10), three drive rollers (56A, 56B, 56C) in the three linear tracks, each having a cylindrical bore (60) around a corresponding one of the three trunnions, and a complement of needle roller bearings (64) between each of the trunnions and the cylindrical bore of the corresponding drive roller. Uniform structural robustness of the elements of the joint is reflected in the magnitudes of three dimensional relationships of the tripod joint, i.e. a trunnion aspect ratio "R_t" (the ratio of the length of the trunnion to the diameter of the trunnion), a drive roller aspect "R_b" (the ratio of the height of the drive roller to the diameter of the drive roller), and a spider diameter ratio "R_s" (the ratio of the roller circle diameter of the tripod joint to the axle bar diameter). In the tripod joint according to this invention the trunnion aspect ratio R_t is in a range less than 0.69, the drive roller aspect R_b is in a range less than 0.3, and the spider diameter ratio R_s is less than 1.9.



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CONSTANT VELOCITY UNIVERSAL JOINT

TECHNICAL FIELD

This invention relates to constant velocity universal joints.

BACKGROUND OF THE INVENTION

Constant velocity universal joints commonly identified as "tripot joints" or "tripod joints" include the following elements: an outer housing having three linear tracks or channels therein, a spider having three cylindrical trunnions projecting radially into the linear tracks, three ring-shaped drive rollers in the three linear tracks each having a cylindrical bore around a corresponding one of the three trunnions, and a complement of needle roller bearings between each of the trunnions and the cylindrical bore of the corresponding drive roller. When the tripod joint is an element of a motor vehicle front wheel drive axle, the spider has a splined bore which receives an inboard end of an axle bar of the drive axle, and the outer housing is connected to a transaxle of the motor vehicle. In that environment, the tripod joint transfers torque from the transaxle to the axle bar concurrent with articulation of the axle bar in response to suspension excursions of the front wheels of the motor vehicle. In designing tripod joints for new applications in which performance characteristics such as torque capacity and/or maximum articulation are different from prior applications, customary design practice has been to simply scale the dimensions of a prior tripod joint up or down and then, by trial and error, make relatively minor adjustments to the scaled dimensions to achieve acceptable performance and durability. Evidence of this practice is that most tripod joints are proportionally similar, just bigger or smaller. While such tripod joints perform satisfactorily, proportional scaling of a prior tripod joint to achieve a new tripod joint often results in a new tripod joint in which some elements have excess structural robustness relative to other elements of the tripod joint. Such excess structural robustness means

that some of the elements of the tripod joint are larger than necessary so that the overall size of the tripod joint is, likewise, larger than necessary.

SUMMARY OF THE INVENTION

This invention is a new and improved tripod joint, the elements of which have dimensional relationships characteristic of substantial uniformity of robustness so that the overall size of the tripod joint is minimized. The tripod joint according to this invention includes an outer housing having three linear tracks or channels therein, a spider having three cylindrical trunnions projecting radially into the linear tracks and a splined bore for an end of an axle bar, three drive rollers in the three linear tracks each having a cylindrical bore around a corresponding one of the three trunnions, and a complement of needle roller bearings between each of the trunnions and the cylindrical bore of the corresponding drive roller. In the tripod joint according to this invention, uniform structural robustness of the elements of the joint is reflected in the magnitudes of three dimensional relationships of the tripod joint, i.e., a trunnion aspect ratio "R_t" (the ratio of the length of the trunnion to the diameter of the trunnion), a drive roller aspect "R_b" (the ratio of the height of the drive roller to the diameter of the drive roller), and a spider diameter ratio "R_s" (the ratio of the roller circle diameter of the tripod joint to the axle bar diameter). Specifically, the tripod joint according to this invention is characterized by a trunnion aspect ratio R_t in a range less than 0.69, a drive roller aspect R_{dr} in a range less than 0.3, and a spider diameter ratio R_s less than 1.9, each of which ranges is below the corresponding range of prior tripod joints having comparable performance characteristics and the aforesaid proportional similarities.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an end view of a tripod constant velocity universal joint according to this invention;

Figure 2 is a sectional view taken generally along the plane indicated by lines 2-2 in Figure 1; and

Figure 3 is a sectional view taken generally along the plane indicated by lines 3-3 in Figure 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a fragmentarily illustrated drive axle for a motor vehicle front wheel drive includes an axle bar 10 and a tripod constant velocity universal joint 12 according to this invention. The tripod joint 12 includes an outer housing 14 having a tubular stem 16 and an integral side wall 18. The stem 16 has a splined bore 20, Figure 2, at which the outer housing is attached to an output shaft, not shown, of a transaxle of a motor vehicle for unitary rotation with the output shaft about a centerline 22 of the outer housing. A retainer, not shown, between the stem 16 and the transaxle output shaft prevents linear translation of the outer housing relative to the transaxle in the direction of the centerline 22.

The side wall 18 of the outer housing 14 has a cylindrical outer surface 24 and a cylindrical inner surface 26. The cylindrical inner surface 26 is interrupted by three linear tracks 28A, 28B, 28C, each of which has a pair of arc-shaped sides 30A, 30B parallel to the centerline 22 and an arch 32 between the sides 30A, 30B. The linear tracks 28A, 28B, 28C extend from an open end 34 of the outer housing to an annular shoulder 36 of the outer housing.

An end 38 of the axle bar 10 is received in a cylindrical bore 40, Figure 2, through the center of a spider 42 of the tripod joint 12. The bore 40 and the end 38 of the axle bar have a plurality of meshing splines 44A, 44B which connect the axle bar and the spider for unitary rotation about a longitudinal centerline 46 of the axle bar. An outside diameter D_a of the splines 44B on the axle bar, Figure 3, corresponds to the outside diameter of the axle bar and to the root diameter of the splines 44A in the cylindrical bore

40 in the spider 42. In a middle position of the axle bar 10 relative to the outer housing 14, Figures 1-3, the centerline 46 of the axle bar 10 coincides with the centerline 22 of the outer housing 14.

The spider 42 has three equally angularly spaced integral cylindrical trunnions 48A, 48B, 48C aligned on respective ones of three radial centerlines 50A, 50B, 50C of the spider in a plane perpendicular to the centerline 46 of the axle bar. Each trunnion 48A, 48B, 48C has an outboard end 52 and an inboard end defined by an annular platform 54 on the spider in a plane perpendicular to the corresponding one of the radial centerlines 50A, 50B, 50C.

The tripod joint 12 further includes three ring-shaped drive rollers 56A, 56B, 56C, each having a spherical outer surface 58, a cylindrical bore 60, and a pair of parallel annular ends 62A, 62B. The cylindrical bores 60 of the drive rollers 56A, 56B, 56C are received around respective ones of the trunnions 48A, 48B, 48C. A complement of needle roller bearings 64 is disposed between the bore 60 of each drive roller and the corresponding one of the trunnions 48A, 48B, 48C. The needle bearings 64 are confined between the bores 60 of the drive rollers and the corresponding trunnions 48A, 48B, 48C by the platforms 54 on the spider 42 and by an annular retainer 66 on each of the trunnions.

The trunnions 48A, 48B, 48C project radially into the linear tracks 28A, 28B, 28C, respectively, in the outer housing 14 with the outer surfaces 58 of corresponding ones of the drive rollers 56A, 56B, 56C facing the arc-shaped sides 30A, 30B of the tracks. The curvature of the outer surfaces of the drive rollers matches the curvature of the arc-shaped sides of the tracks. Torque is transferred from the outer housing 14 to the axle bar 10 through the drive rollers 56A, 56C, 56C, the needle bearings 64, and the trunnions 48A, 48B, 48C. Relative movement between the trunnions and the outer housing in the direction of the longitudinal centerline 22 of the outer housing is accompanied by rolling and/or sliding of the drive rollers in the linear tracks

depending upon whether or not the axle bar 10 is articulated relative to the outer housing.

Exhaustive analysis of the stresses prevailing in the tripod joint during torque transfer, e.g., contact stresses between the needle bearings 64 and the trunnions 48A, 48B, 48C, contact stresses between the needle bearings 64 and the cylindrical bores 60 of the drive rollers 56A, 56B, 56C, and stresses in the trunnions 48A, 48B, 48C at the annular platforms 54, has revealed that when certain dimensional relationships between elements of the tripod joint are in previously unused low ranges, substantially uniform robustness of the drive rollers 56A, 56B, 56C, the needle bearings 64, and the trunnions 48A, 48B, 48C is achieved. The circumstance of such uniform robustness results, in turn, in the tripod joint 12 having minimum overall dimensions for a given torque capacity because no single element is constructed larger and more robust than is required for the particular torque capacity of the joint.

Referring to Figures 2-3, a first important dimensional relationship of the tripod joint 12 is the trunnion aspect ratio (R_t) defined by the equation $R_t=L_t/D_t$, where L_t is the length of each trunnion between the platform 54 and the retainer 66, and D_t is the diameter of each trunnion. A second important dimensional relationship of the tripod joint 12 is the drive roller aspect ratio (R_{dr}) defined by the equation $R_{dr}=H_{dr}/D_{dr}$, where H_{dr} is the height of each drive roller in the direction of the corresponding one of the radial centerlines 50A, 50B, 50C between the ends 62A, 62B of the drive roller and D_{dr} is the diameter of each drive roller. A third important dimensional relationship of the tripod joint 12 is the diameter ratio (R_s) of the spider 42 defined by the equation $R_s=RCD/D_a$, where RCD is the roller circle diameter of the tripod joint 12, i.e., the diameter of a circle through the centers of the drive rollers 56A, 56B, 56C, and D_a is the diameter of the axle bar 10.

The tripod joint 12 according to this invention is constructed with R_t in a range of less than 0.69, R_{dr} in a range less than 0.3, and R_s in a range less than 1.9. These dimensional relationships have been observed to yield a

tripod joint in which the robustness of the drive rollers 56A, 56B, 56C, the needle bearings 64 and the trunnions 48A, 48B, 48C is substantially more uniform than in prior tripod joints in which one or more of R_t, R_b, and R_s is outside of the specified ranges. Accordingly, for a desired torque capacity of the tripod joint 12, the overall dimensions of the tripod joint are minimized relative to prior tripod joints of comparable torque capacity.

Claims

1. A tripod constant velocity universal joint (12) including

an outer housing (14) having three linear tracks (28A, 28B, 28C),

a spider (42) in said outer housing (14) having three cylindrical trunnions (48A, 48B, 48C) aligned on respective ones of three equally angularly spaced radial centerlines (50A, 50B, 50C) of said spider and a cylindrical bore (40) through said spider,

each of said cylindrical trunnions (48A, 48B, 48C) having an outboard end (52) projecting into a respective one of said three linear tracks (28A, 28B, 28C) and an inboard end where said trunnion merges with said spider,

an axle bar (10) having a distal end (38) projecting into said cylindrical bore (40) in said spider,

a plurality of splines (44A) on said distal end (38) of said axle bar (10) meshing with a plurality of splines (44B) in said cylindrical bore (40) in said spider and having an outside diameter corresponding to an outside diameter (D_a) of said axle bar,

three annular platforms (54) on said spider (42) each at said inboard end of a respective one of said three cylindrical trunnions (48A, 48B, 48C),

three drive rollers (56A, 56B, 56C) in respective ones of said three linear tracks (28A, 28B, 28C) each having a cylindrical bore (60) around the corresponding one of said cylindrical trunnions (48A, 48B, 48C),

a complement of needle roller bearings (64) between each of said three cylindrical trunnions (48A, 48B, 48C) and said cylindrical bore (60) in the corresponding one of said drive rollers (56A, 56B, 56C); and

three annular retainers (66) on respective ones of said three cylindrical trunnions (48A, 48B, 48C) at said outboard ends (52) thereof preventing dislodgment therefrom of the corresponding one of said drive rollers (56A, 56B, 56C) and the corresponding complement of said needle roller bearings (64),

wherein the improvement comprises:

said tripod constant velocity universal joint (12) having

a trunnion aspect ratio $R_t = L_t/D_t$ less than 0.69,

where

L_t is the length of each of said cylindrical trunnions (48A, 48B, 48C) between said inboard end (54) and said annular retainers (66), and

D_t is the diameter of each of said cylindrical trunnions (48A, 48B, 48C);

a drive roller aspect ratio $R_{dr} = H_{dr}/D_{dr}$ less than 0.3,

where

H_{dr} is the height of each drive roller (56A, 56B, 56C) in the direction of said radial centerline (50A, 50B, 50C) of the corresponding one of said three cylindrical trunnions (48A, 48B, 48C), and

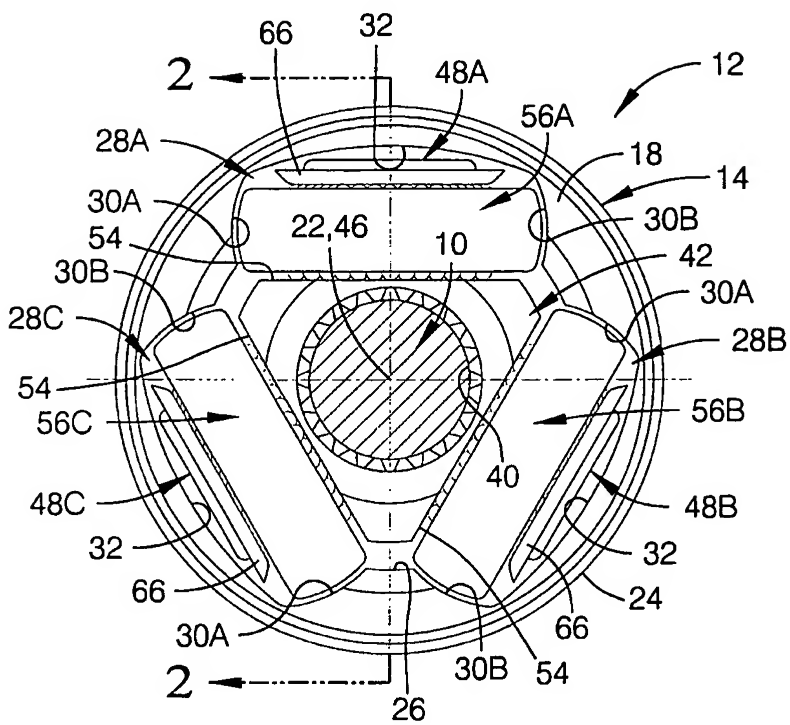
D_{dr} is the outside diameter of each drive roller (56A, 56B, 56C); and

a spider diameter ratio $R_s = RCD/D_a$ less than 1.9,

where

RCD is the roller circle diameter of said tripod constant velocity universal joint, and

D_a is the outside diameter of said axle bar.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66
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48A
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56A
28A
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30A
30B
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28C
28B
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56C
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48C
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30A
30B
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FIG. 1

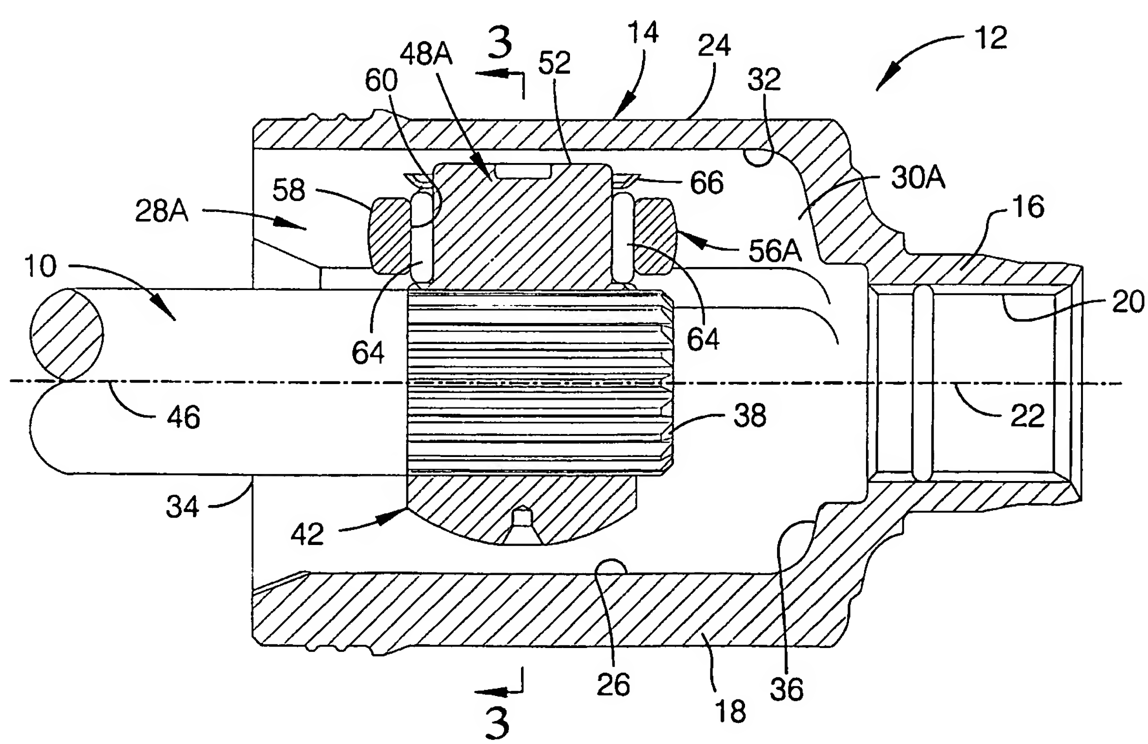
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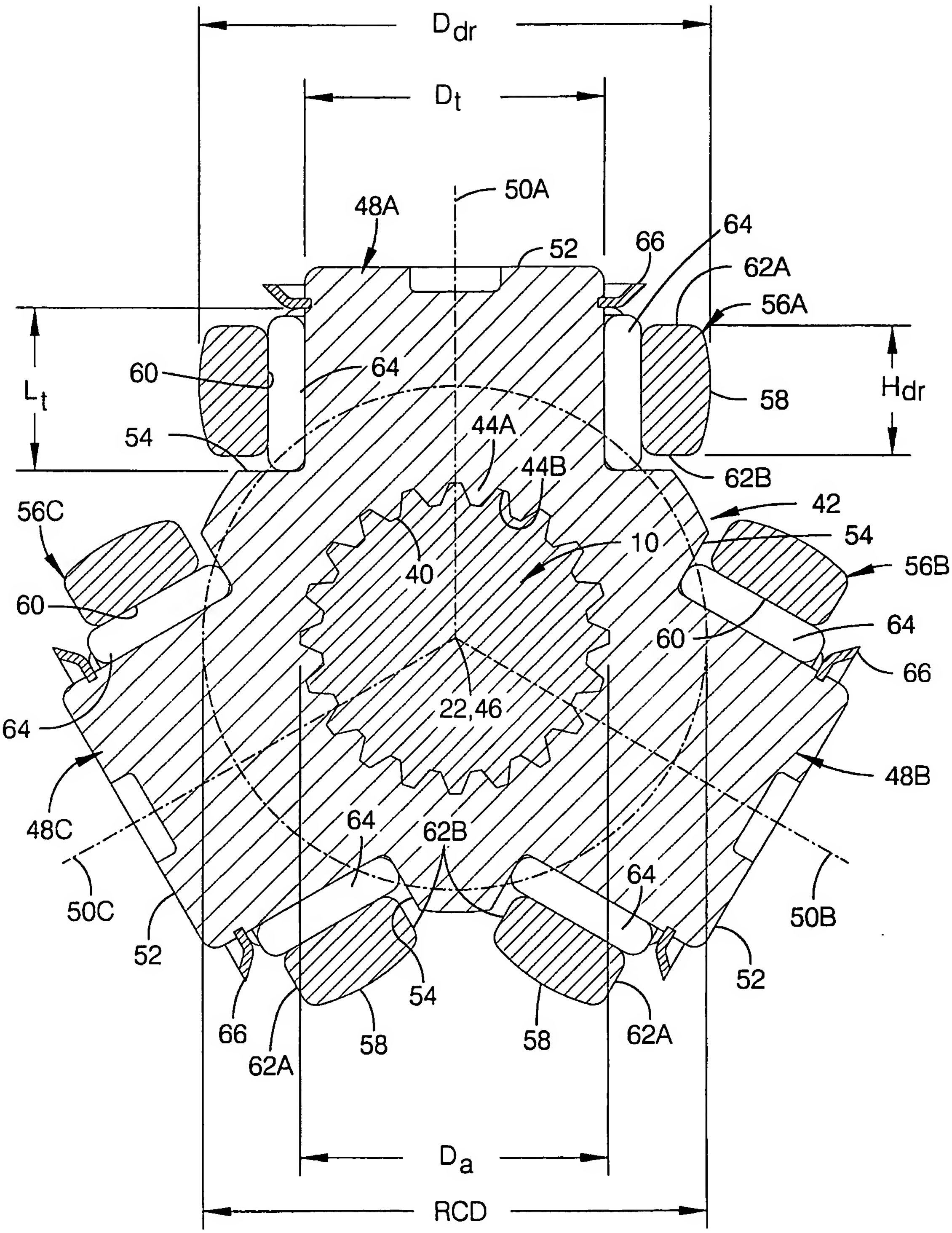
FIG. 2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64
48B
48C
64
62B
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50C
50B
52
54
52
66
58
58
62A
62A
Da
RCD

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/21732

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16D3/205

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	EP 0 802 341 A (NTN TOYO BEARING CO LTD) 22 October 1997 see the whole document ---	1
A	FR 2 550 292 A (GLAENZER SPICER SA) 8 February 1985 see figure 2 -----	1

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☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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